ATENT COOPERATION TRE..TY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 06 October 1999 (06.10.99)	
International application No. PCT/SE99/00047	**Applicant's or agent's file reference** P33752PC00
International filing date (day/month/year) 15 January 1999 (15.01.99)	**Priority date** (day/month/year) 16 January 1998 (16.01.98)
Applicant JOHANSSON, Ingemar et al	

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   16 August 1999 (16.08.99)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

   [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Jean-Marie McAdams

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P33752PC00	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/SE 99/00047	International filing date *(day/month/year)* 15 January 1999	(Earliest) Priority Date *(day/month/year)* 16 January 1998
Applicant SENAD Teknikbetong AB et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] Certain claims were found unsearchable (See Box I).

2. [ ] Unity of invention is lacking (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [X] the text is approved as submitted by the applicant.
   - [X] the text has been established by this Authority to read as follows:

     Method for injecting of foamed concrete and a foamed concrete.

5. With regard to the abstract,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:

   Figure No. _____
   - [ ] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.

   [X] None of the figures.

G17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00047

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 33/138, C04B 38/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E21B, C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5529123 A (CARPENTER ET AL), 25 June 1996 (25.06.96) --	1-11
A	GB 2164328 A (BLUE CIRCLE INDUSTRIES PLC), 19 March 1986 (19.03.86) --	1-11
A	SE 506359 C2 (AKZO NOBEL SURFACE CHEJISTRY AB), 8 December 1997 (08.12.97) --	1-11
A	GB 2192392 A (REDLAND ROOF TILES LIMITED), 13 January 1988 (13.01.88) --	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 1999	30 -04- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Bäcknert Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/03/99

International application No.
PCT/SE 99/00047

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5529123 A	25/06/96	NONE	
GB 2164328 A	19/03/86	AU 4866985 A	08/04/86
		EP 0198849 A	29/10/86
		JP 62500167 T	22/01/87
		WO 8601795 A	27/03/86
SE 506359 C2	08/12/97	AU 1043897 A	19/06/97
		AU 2636197 A	12/11/97
		CA 2248334 A	30/10/97
		EP 0868270 A	07/10/98
		EP 0894080 A	03/02/99
		NO 984853 D	00/00/00
		SE 9601471 A	19/10/97
		WO 9739992 A	30/10/97
GB 2192392 A	13/01/88	NONE	

RECORD COPY

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/SE99/00047

International Filing Date 15-01-1999

The Swedish Patent Office PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* P33752PC00

* title changed see ISR

Box No. I TITLE OF INVENTION

Method for injection of concrete *

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SENAD Teknikbetong AB
Box 31
S-841 21 ÅNGE
Sweden

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

JOHANSSON, Ingemar
Färjevägen 1
S-841 34 ÅNGE
Sweden

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below ~~is hereby~~/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Örjan Westerlund
AB STOCKHOLMS PATENTBYRÅ, Zacco & Bruhn (publ)
Box 23101, S-104 35 STOCKHOLM, Sweden

Telephone No. +46 8 729 95 00

Facsimile No. +46 8 31 83 15

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SVEDMAN, Kjell
Ovansjö 288 B
S-841 91 ÅNGE
Sweden

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☒ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

IMRELL, Kenth
Parteboda 2243
S-841 92 ÅNGE
Sweden

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☒ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☐ the United States of America only
- ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
- ☐ the United States of America only
- ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." [indicate the number of the Box] and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular.

*(i) **if more than two persons are involved as applicants and/or inventors** and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

*(ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication **"the States indicated in the Supplemental Box"** is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

*(iii) if, in Box No. II or in any of the sub-boxes of Box No. III, **the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America**: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

*(iv) if, in addition to the agent(s) indicated in Box No. IV, there are **further agents**: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

*(v) if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "**patent of addition**," or "**certificate of addition**," or if, in Box No. V, the name of the United States of America is accompanied by an indication "**continuation**" or "**continuation-in-part**": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;*

*(vi) if, in Box No. VI, there are **more than three earlier applications whose priority is claimed**: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI;*

*(vii) if, in Box No. VI, **the earlier application is an ARIPO application**: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.*

*2. If, with regard to the **precautionary designation statement** contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.*

*3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning **non-prejudicial disclosures or exceptions to lack of novelty**: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.*

CONTINUATION OF BOX IV:

Further representatives:

Agvald-Glas, Gunilla
Bernhult, Lennart
Bjerndell, Per
Boije-Jansson, Kerstin
Brundin, Gabriella
Grahn, Cecilia
Granström, Lars-Eric
Grip, Joakim
Hansson, Hans-Erik
Hansson, Sven A.
Hinz, Udo
Holmberg, Martin
Karlsson, Per Tomas
Lennefors, Stefan
Lundström, Maria
Nilsson, Brita
Nordén, J. Åke
Petré, Urban
Rilton, Kristina
Westerlund, Örjan
Åström, Elsa

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☒ AP **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SZ** Swaziland, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☒ AL Albania .....
- ☒ AM Armenia .....
- ☒ AT Austria .....
- ☒ AU Australia .....
- ☒ AZ Azerbaijan
- ☒ BA Bosnia and Herzegovina .....
- ☒ BB Barbados
- ☒ BG Bulgaria .....
- ☒ BR Brazil .....
- ☒ BY Belarus .....
- ☒ CA Canada
- ☒ CH and LI Switzerland and Liechtenstein
- ☒ CN China .....
- ☒ CU Cuba .....
- ☒ CZ Czech Republic .....
- ☒ DE Germany .....
- ☒ DK Denmark .....
- ☒ EE Estonia .....
- ☒ ES Spain .....
- ☒ FI Finland .....
- ☒ GB United Kingdom
- ☒ GD Grenada
- ☒ GE Georgia .....
- ☒ GH Ghana .....
- ☒ GM Gambia
- ☒ HR Croatia .....
- ☒ HU Hungary .....
- ☒ ID Indonesia
- ☒ IL Israel .....
- ☒ IN India .....
- ☒ IS Iceland
- ☒ JP Japan .....
- ☒ KE Kenya .....
- ☒ KG Kyrgyzstan .....
- ☒ KP Democratic People's Republic of Korea .....
- ☒ KR Republic of Korea .....
- ☒ KZ Kazakhstan .....
- ☒ LC Saint Lucia
- ☒ LK Sri Lanka
- ☒ LR Liberia
- ☒ LS Lesotho .....
- ☒ LT Lithuania
- ☒ LU Luxembourg
- ☒ LV Latvia
- ☒ MD Republic of Moldova .....
- ☒ MG Madagascar .....
- ☒ MK The former Yugoslav Republic of Macedonia .....
- ☒ MN Mongolia
- ☒ MW Malawi .....
- ☒ MX Mexico .....
- ☒ NO Norway
- ☒ NZ New Zealand .....
- ☒ PL Poland .....
- ☒ PT Portugal .....
- ☒ RO Romania
- ☒ RU Russian Federation .....
- ☒ SD Sudan
- ☒ SE Sweden
- ☒ SG Singapore
- ☒ SI Slovenia .....
- ☒ SK Slovakia .....
- ☒ SL Sierra Leone
- ☒ TJ Tajikistan .....
- ☒ TM Turkmenistan .....
- ☒ TR Turkey .....
- ☒ TT Trinidad and Tobago .....
- ☒ UA Ukraine .....
- ☒ UG Uganda .....
- ☒ US United States of America .....
- ☒ UZ Uzbekistan .....
- ☒ VN Viet Nam .....
- ☒ YU Yugoslavia .....
- ☒ ZW Zimbabwe .....

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☐ .....
- ☐ .....
- ☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)*

20/SE

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 16 JANUARY 1998 [1999]	9800082-1	Sweden		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): 9800082-1

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*: ISA / SE

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:
Date *(day/month/year)* 16. 01. 1998 Number SE/1998/00155 Country *(or regional Office)* SE

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	:	5 ✓
description (excluding sequence listing part)	:	9 ✓
claims	:	2 ✓
abstract	:	1 ✓
drawings	:	1 ✓
sequence listing part of description	:	
Total number of sheets	:	18

This international application is **accompanied by** the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify)*: List of further representatives

Figure of the drawings which should accompany the abstract:

Language of filing of the international application:

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Stockholm, 15 January 1999

AB STOCKHOLMS PATENTBYRÅ
Zacco & Bruhn (publ)

Lennart Bernhult
Representative of the applicant

For receiving Office use only

1. Date of actual receipt of the purported international application: 15 -01- 1999
2. Drawings: ☒ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /SE
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau: 15 FEBRUARY 1999 [15. 02. 99]

varvid luft drar med sig cement och eventuellt förekommande finpartikulärt material in i kaviteterna, där sedimentering och hydratisering äger rum. Trycket vid injekteringen av skumbetongen är lämpligen lägre än 3 bar medan det förhöjda trycket vanligtvis är över 6 bar.

Genom metoden enligt uppfinningen har det visat sig möjligt att avsevärt förstärka stabiliseringen genom att den hydratiserbara betongblandningen kan tränga längre in i sprickorna än vid injektering av en konventionell betongblandning. Cementen är lämpligen finmald till en sådan partikelstorlek att minst 95% passerar en sikt med maskvidden 64 µm, företrädesvis 32 µm och allra helst 16 µm, om en penetrering in i fina kaviteter önskas. Luftbubblorna och dess utströmning genom kaviteterna förhindrar även inträngning av vattnet under injekteringen och förhindrar därmed, åtminstone delvis, massans utspädning med vatten och försvårar eventuell bortspolning. För det fall att genomströmningen av vatten är extremt kraftig eller en låg vattenpermeabilitet eftersträvas, har det enligt uppfinningen visat sig lämpligt att använda en hydrofob skumbetong. Företrädesvis hydrofoberas skumbetongen i en sådan omfattning att den inte spontant blandar sig med vatten. Härigenom undvikes utspädning av blandningen med vatten samtidigt som risken för bortspolning kraftigt reduceras.

Uppfinningen beskrives närmare nedan med referens till ritning, där Figur 1 visar betongmassans inträngning i en spricka och Figur 2 är en förstorad bild av det inringade partiet i Figur 1.

Föreliggande uppfinning hänför sig även till en lågviskös, pumpbar skumbetong, vilken är baserad på cement med en sådan partikelstorlek att 95 viktprocent passerar en sikt med maskvidden 64 µm och med en porvolym av minst 20 volymprocent. Lämpligen innehåller skumbetongen följande komponenter:

100 viktdelar cement, mald till en sådan kornstorlek att 95 viktprocent passerar en sikt med maskvidden 64 µm, företrädesvis 32 µm,

0.1-1 viktdelar av en dispergator, såsom ett protein, en anjonisk tensid och/eller en polymer, och
35-80 företrädesvis 50-70 viktdelar vatten,
0-10 viktdelar finpartikulärt material med en partikelstorlek mindre än cementens,
0-2.5 viktdelar av ett harts med en molekylvikt av under 10 000 och ett förtvålningstal av 100-250, och
0-2.5 viktdelar av en accelerator, retardator och/eller förtjockningsmedel som reglerar cementens hydratisering eller gradvis höjer betongens viskositet, och
0-2 viktdelar av ett svällande tillsatsmedel.

Skumbetongens porvolym är lämpligen mellan 40% och 85% och företrädesvis mellan 50% och 80%. Vid mycket trånga kaviteter, till exempel mikrosprickor i berg, innehåller betongen lämpligen 1-10 viktdelar finpartikulärt material per 100 viktdelar cement. För det fall att en hydrofob skumbetong önskas, kan hydrofobiteten ökas genom att tillsätta harts i en mängd av 0.1-2.5 viktdelar per 100 viktdelar cement och eventuellt finpartikulär bentonit i en mängd av 0.1-3 viktdelar per 100 viktdelar cement. Betongen har vanligtvis en densitet av 300-1800 kg/m^2, företrädesvis 400-1500 kg/m^2.

Cement är ett hydrauliskt bindemedel, som med vatten bildar en pasta och härdar genom hydratisering. Härdningen beror i första hand på bildning av kalciumsilikathydrat. Den mest betydelsefulla silikatcementinnehållande kompositionen är Portlandcementklinker. Vid tilllämpning av uppfinningen användes företrädesvis Portlandcement på grund av dess goda allround-egenskaper. Den innehåller bland annat trikalciumsilikat, dikalciumsilikat, trikalciumaluminat och kalciumaluminiumferrit. Andra exempel på lämpliga cementtyper är Portland slaggcement, Portland flygaskecement, Portland pozzolanacement, färgat Portlandcement, vitt Portlandcement, långsamt härdande Portlandcement och snabbt härdande Portlandcement, vilka samtliga är baserade på Portland cementklinker. Vid användning av cement i injekteringsbetong är

det lämpligt att mala cement extra till en sådan partikelstorlek att minst 95 viktprocent passerar en sikt med maskvidden 32 µm, företrädesvis 16 µm för att betongen lättare skall tränga in i trånga kaviteter. Om omständigheterna så kräver, kan en ännu finare cement användas.

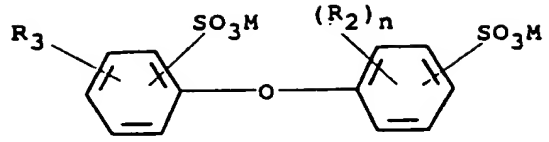
Dispergatorerna tillsättes som luftporbildande och stabiliserande tillsatser. Exempel på sådana tillsatser är proteiner, nonjoniska alkylenoxidadduckter, xylensulfonat, alkylsulfat, alkyletersulfat, olefinsulfat och polymera sulfonsyragruppinnehållande föreningar, såsom lignosulfonat, naftalensulfonatformaldehydkondensat och melaminsulfonatformaldehydkondensat samt blandningar därav. Proteinerna, de nonjoniska alkylenoxidaddukterna och de kortkedjiga anjoniska föreningarna påverkar i första hand luftporbildningen medan de polymera anjoniska polyelektrolyterna primärt bidrar till förbättrad stabilitet och pumpbarhet.

Speciellt föredragna dispergatorer är anjoniskt ytaktiva disulfonater av den typ, som beskrives i patentansökan WO 97/39992, där disulfonaten har den allmänna formeln

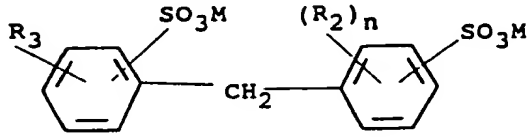
$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

där R är en alifatisk grupp med 4-20 kolatomer, m är ett tal 1 eller 2, varvid summan av antalet kolatomer i gruppen eller i grupperna R är 6-30, R_1 är en aromatisk grupp innehållande minst 2 aromatiska ringar och 10-20 kolatomer, och M är en företrädesvis monovalent katjon eller väte. Vanligtvis innehåller gruppen R_1 endast kol och väte, men även syreatomer kan ingå, exempelvis i form av ketongrupper. Förutom att dessa föreningar har en luftindragande förmåga ger de en hydrofob skumbetong, som är lågviskös och lätt pumpbar.

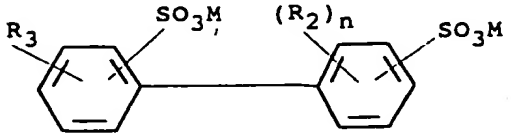
Disulfonaten med formeln I utgöres lämpligen av föreningar, där R är en alifatisk grupp med 6-14 kolatomer och R_1 är en aromatisk grupp med 10-17 kolatomer och två aromatiska ringar. Exempel på sådana disulfonat är de med formlerna



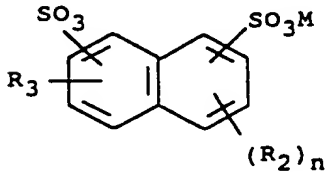
(II)



(III)



(IV)



(V)

där R_3 är en alifatisk grupp med 4-20 kolatomer, M har den ovan angivna betydelsen, R_2 är en alifatisk grupp med 1-14 kolatomer och n är 0 eller 1, företrädesvis 0. Grupperna R_3 och R_2 är exempelvis en butylgrupp, en hexylgrupp, en oktylgrupp, en decylgrupp eller en dodecylgrupp, som kan vara rak eller grenad. Gruppen R_2 kan dessutom lämpligen vara en lägre alkylgrupp, såsom en metyl- eller etylgrupp. Summan av antalet kolatomer i grupperna R_3 och R_2 är företrädesvis från 8-24. Dessa disulfonat ger en stabil, lågviskös skumbetong som lätt låter sig pumpas. Speciellt föredragna är alkylsubstituerade difenyletrar.

Det finpartikulära materialet är exempelvis flygaska, bentonit (myanit), stendamm, finmald kalk, gips och kiseldioxid med en partikelstorlek som är mindre än cementens. Lämpligen bör den ha en partikelstorlek som till minst 95% understiger 5 µm och en specifik yta i storleksordningen minst 1 500 m^2/kg eller högre. Kiseldioxidstoff, vanligtvis benämnd silika, med en partikelstorlek av 0.1 µm och en specifik yta av $2 \cdot 10^4$ är exempel på ett finpartikulärt material med en god inträngningsförmåga. Flygaska, kalk och

kiseldioxid påverkar även betongens bindning.

Tillsats av hartserna, som kan vara syntetiska eller naturliga, eller derivat därav, göres i första hand för att öka betongens hållfasthet, vattenavvisande egenskaper (hydrofobitet) och homogenitet. Hartserna och deras derivat kan innehålla en eller flera aromatiska och/eller alifatiska grupper med minst 12, företrädevis 16-35 kolatomer. Grupperna kan vara såväl mättade som omättade. Föredragna hartser är sådana med ett syratal från 4-170 och med ett förtvålningstal från 150-175. Exempel på lämpliga hartser är olika hartssyror och blandningar därav, såsom kolofonium, och deras dimeriserade derivat samt helt eller delvis förtvålade, förestrade och eller hydrerade derivat därav. Exempel på lämpliga hydroxylföreningar för förestring är metanol, glykol, glycerol och pentaerytritol. Andra exempel är modifierade kolofoniumhartser modifierade med omättade fettsyror, såsom maleinsyra och deras företrädesvis partiellt förestrade derivat samt fenolmodifierade kolofonium. Exempel på lämpliga fenoler är 4-tert-butylfenol, nonylfenol och 4,4'-difenylolpropan (bisfenol A).

Andra exempel på tillsatser är retardatorer eller acceleratorer, som reglerar cementens hydratisering så att den anpassas till de förhållanden som råder vid injekteringen och sker vid önskad tidpunkt. Exempel på acceleratorer är alkalisalter, såsom kalciumklorid, natriumhydroxid, kaliumkarbamid och natriumaluminat, medan exempel på retardatorer är sackarider, fosfater, citronsyra och lignosulfonat. Den senare har också en påtaglig dispergerande effekt. Även tillsats av förtjockningsmedel, som gradvis utvecklar sin viskositet, kan hjälpa till att förhindra att skumbetongen bortspolas av inträngande vatten innan den härdat. Exempel på sådana förtjockningsmedel är sackaridföreningar, såsom nonjoniska cellulosaetrar, polyuretaner och polyakrylater. Exempel på lämpliga cellulosaetrar är hydroxietylcellulosa, metylcellulosa, metylhydroxietylcellulosa och etylhydroxietylcellulosa.

Svällande tillsatser inblandas för att motverka

volymminskning och därmed förhindra att sprickor och håligheter blir ofullständigt utfyllda. Exempel på svällande tillsatsmedel är aluminiumpulver.

Vid injektering av skumbetonger är det av synnerlig vikt att den är stabil. Skulle blandningen ej vara stabil kommer de enskilda cementpartiklarna att sedimentera på grund av sin egenvikt och därmed blockera och omöjliggöra ytterligare injektering exempelvis ett i ett berg befintligt spricksystem. Det finpartikulära materialet med stor specifik yta som exempelvis kiseldioxid, gips och myanit, ökar stabiliteten hos skumbetongen och kan således bäras av skumbetongen ända fram till bergets sprickor. Användning av skumbetong innehållande en hög lufthalt ger en lågviskös betong med låg skjuvhållfasthet. Detta faktum jämte det faktum att luftbubblorna bär partiklarna på sina ytor, bidrar till låg viskositet hos massan och innebär att betongen kan injekteras med lågt pumptryck men ändå erhålla en god inträngning. Det låga pumptryck som behövs för injektering av skumbetongen ger också den fördelen att lägre krav på förankring av adaptrar vid borrhål kan ställas. Vidare kan säkerheten för personal, som hanterar utrustning, höjas och riskerna för slangsprängning och adaptersläpp i stort sett elimineras.

I figur 1 visas den med hög lufthalt försedda betongens 1 inträngning i en spricka, 2 i ett berg eller liknande. Med pilen 3 visas betongens strömningsriktning, varvid luftbubblorna i betongen betecknas med 4.

Såsom nämnts tidigare pumpas betongen 1 i företrädesvis en slang och/eller borrhål fram till bergets spricka 2, varvid pumptrycket hålles på en låg nivå. Såsom även nämnts tidigare bär luftbubblorna 4 cement och andra materialpartiklar effektivt fram till och in i sprickan. Därefter ökas trycket i slangen avsevärt, vilket innebär att luftbubblorna inne i sprickan kollapsar och det uppstår en luftströmstransport av partiklar och vatten in i sprickans inre. Detta innebär att cementpartiklarna agglomererar långt in i sprickan och härdar till en betong med hög densitet, varvid

sprickan tätas.

Enligt uppfinningen kan den vattenhaltiga betongblandningen framställas genom att vatten, inkluderande dispergeringsmedel och andra i vatten lösliga eller dispergerbara organiska tillsatsmedel, blandas med torrbruk, innehållande bland annat cement och eventuellt finpartikulärt material, till en homogen uppslamning.

Ett annat sätt är att under omrörning sammanföra en huvudblandning, innehållande huvudmängden cement, huvudmängden vatten och finpartikulärt material, och en kompletterande blandning innehållande resterande vatten, resterande cement, dispergatorn och eventuellt ingående harts och andra organiska tillsatsmedel. Viktförhållandet mellan huvudblandningen och den kompletterande blandningen är vanligtvis inom intervallet 20:1 till 2:1.

Ytterligare ett sätt att framställa skumbetongen är att i en diskontinuerlig eller kontinuerlig betongblandare tillsätta vatten, dispergatorn och eventuellt ingående harts och andra organiska tillsatsmedel samt en mindre mängd av ingående cement, vanligtvis 2-40, företrädesvis 5-30 viktprocent av den totala mängden cement (lämpligen i angiven turordning). Den erhållna kompositionen omröres under volymökning till en homogen, stabil luftinnehållande betongblandning, varefter resterande cement och det finpartikulära materialet tillsättes i ett eller flera steg eller kontinuerligt och inblandas under omrörning.

Föreliggande uppfinning åskådliggöres ytterligare av följande utföringsexempel.

Exempel 1.

Ett hus med betonggrund byggt på ett underlag av sand och sten och utsatt för pågående sättningar, stabiliserades med en skumbetong enligt uppfinningen. Skumbetongen, som hade en densitet av 495 kg/m^3 och en luftporvolym av 69%, var baserad på Portlandcement med en sådan partikelstorlek att över 95 viktprocent passerade en sikt med maskvidden 32 µm och innehöll dessutom per 100 viktdelar cement 0.7 viktdelar decylsubstituerad difenyleterdisulfonat med formeln II

och 0.35 viktdelar Aquatac 6085, en glycerolhartssyraester med en aktivhalt av 59 viktprocent från Bergvik Kemi AB.

Injekteringsslangarna grävdes ner till ett djup av 100 cm och skumbetongen injekterades vid ett tryck av 1 bar och när ingen ytterligare skumbetong gick att injektera vid detta tryck, höjdes trycket till 10 bar, varefter det hela tilläts att härda.

Efter injekteringen upphörde sättningarna och den injekterade skumbetongen inspekterades genom att gräva upp materialet runt injekteringsslangarna. Den skumbetong som fanns mellan stenar och grus hade förväntad luftporvolym, medan den skumbetong som pressats in i trånga utrymmen och sprickor hade ingen eller mycket låg luftporvolym.

Patentkrav

1. Metod att stabilisera grus, sand, makadam, berg och betongkonstruktioner, som är spruckna, porösa eller uppvisar andra svårtillgängliga kaviteter, samt täta dessa mot vattenflöden genom injektering av en pumpbar, lågviskös betong, som är baserad på en vattendispersion innehållande cement, k ä n n e t e c k n a d av att man injekterar en skumbetong med en porvolym av minst 20 volymprocent till de svårtillgängliga kaviteter, som skall tätas, varvid man först injekterar skumbetongen vid så lågt tryck att skumbetongen förblir intakt, och därefter applicerar ett förhöjt tryck, så att skumbetongen, som befinner sig inne i eller i närheten av kaviteterna, pressas längre in i dessa.

2. Metod enligt krav 1, varvid vattendispersionen innefattar finmald cement, en dispergator och eventuellt finpartikulärt material med stor specifik yta, k ä n n e t e c k n a d av att i skumbetongen befintliga luftbubblor kollapsar, då skumbetongen pressas längre in i kaviteterna, varvid utströmmande luft drar med sig cement och det eventuellt förekommande finpartikulära materialet in i kaviteterna, där sedimentering och hydratisering äger rum.

3. Metod enligt krav 1 eller 2, k ä n n e t e c k n a d av att skumbetongen har en luftporvolym av 40-85%, är hydrofob och inte spontant låter sig blandas med vatten.

4. Metod enligt något av föregående krav, k ä n n e t e c k n a d av att skumbetongen innehåller en anjonisk tensid med den allmänna formeln

$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

där R är en alifatisk grupp med 4-20 kolatomer, m är ett tal 1 eller 2, varvid summan av antalet kolatomer i gruppen eller i grupperna R är 6-30, R_1 är en aromatisk grupp innehållande minst 2 aromatiska ringar och 10-20 kolatomer, och M är en företrädesvis monovalent katjon eller väte.

5.Metod enligt något av föregående krav, k ä n n e t e c k n a d av att skumbetongen innehåller en accelerator, retardator och/eller ett förtjockningsmedel.

6. Metod enligt något av föregående krav, k ä n n e t e c k n a d av att injektionen av betongen sker vid ett tryck lägre än 3 bar och att trycket därefter höjes till minst 6 bar.

7. Skumbetong, k ä n n e t e c k n a d av att den har en porvolym av minst 20% och innehåller finmald cement med en sådan partikelfördelning att minst 95% passerar en sikt med en maskvidd av 64 µm, och 2-10%, räknat på cementens vikt, av ett finpartikulärt material med en partikelstorlek som är mindre än cementens.

8. Skumbetong enligt krav 7, k ä n e t e c k n a d av att den har en luftporvolym av minst 40-85% och innehåller

0.1-1 viktdel av en dispergator,

35-80 företrädesvis 50-70 viktdelar vatten,

0-10 viktdelar finpartikulärt material, med en partikelstorlek som är mindre än cementens,

0-2.5 viktdelar av ett harts med en molekylvikt av under 10 000 och ett förtvålningstal av 100-250,

0-2.5 viktdelar av en accelerator, retardator och/eller ett förtjockningsmedel som reglerar cementens hydratisering eller gradvis höjer betongens viskositet, och

0-2 viktdelar av ett svällande tillsatsmedel per 100 viktdelar cement.

9. Skumbetong enligt krav 8, k ä n n e t e c k n a d av att dispergatorn innehåller ett disulfonat med den allmänna formeln

$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

där R är en alifatisk grupp med 4-20 kolatomer, m är ett tal 1 eller 2, varvid summan av antalet kolatomer i gruppen eller i grupperna R är 6-30, R_1 är en aromatisk grupp innehållande minst 2 aromatiska ringar och 10-20 kolatomer, och M är en företrädesvis monovalent katjon eller väte.

10. Skumbetong enligt något av kraven 7-9, k ä n n e t e c k n a d av att de innehåller 0,1-2,5 viktdelar av hartset i krav 8.

11. Skumbetong enligt något av kraven 7-10, k ä n n e t e c k n a d av att det innehåller 2-10 viktprocent av det finpartikulära materialet i krav 8, och att cementen har en sådan partikelstorlek att 95 viktprocent passerar en sikt med maskvidden 32 µm.

S A M M A N D R A G

Föreliggande uppfinning avser en metod att stabilisera grus, sand, makadam, berg och betongkonstruktioner som är spruckna, porösa eller uppvisar andra svårtillgängliga kaviteter samt att täta dessa mot vattenflöden genom att injektera en pumpbar, lågviskös skumbetong som är baserad på en vattendispersion, som innehåller finmald cement, en dispergator och eventuellt finpartikulärt material med stor specifik yta. Uppfinningen beskriver även en skumbetong, som har en porvolym av minst 20% och innehåller finmald cement med en sådan partikelfördelning att minst 95% passerar en sikt med en maskvidd av 64 µm, och 2-10%, räknat på cementens vikt, av ett finpartikulärt material med en partikelstorlek som är mindre än cementens.

PCT/SE 99/00047
15 -03- 1999

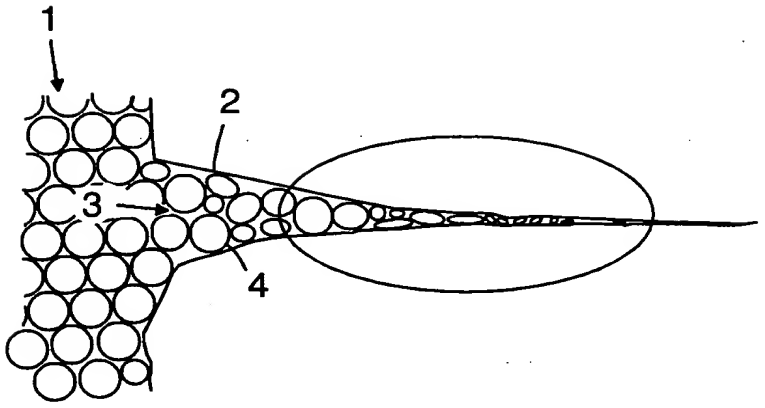


FIG.1

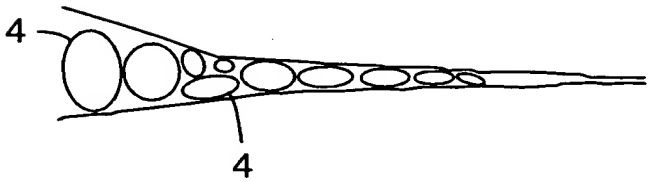


FIG.2

16

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 103375200ÖW	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/SE99/00047	International filing date *(day/month/year)* 15.01.1999	Priority date *(day/month/year)* 16.01.1998
International Patent Classification (IPC) or national classification and IPC7 E21B 33/138, C04B 38/00		
Applicant SENAD Teknikbetong AB et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
16.08.1999	25.04.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Authorized officer Christer Bäcknert / MR Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SE99/00047

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☒ the international application as originally filed.

☐ the description, pages _____, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____,
pages _____, filed with the letter of _____.

☐ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. _____, filed with the letter of _____,
Nos. _____, filed with the letter of _____.

☐ the drawings, ~~sheets~~/fig _____, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____,
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

V. Resoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-11	YES
	Claims		NO
Inventive step (IS)	Claims	1-11	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-11	YES
	Claims		NO

2. Citations and explanations

The invention relates to a method of stabilising and sealing gravel, sand, crushed rock etc. wherein the crushed or porous zones are difficult to access. The invention also relates to a foamed concrete for use in the method.

When stabilising and sealing non-consolidated zones in gravel, rock, etc. where the zones are difficult to access, it is generally known to inject or pump an easy-flow concrete into the zones. However, there one has encountered problems in making the injected concrete reach far enough into the zones.

The invention solves this problem by providing a method wherein an aerated concrete with a pore volume of at least 20% by volume is injected into the cavities at such a low pressure that the air bubbles remain intact. Subsequently, the concrete is subjected to an increased pressure, whereby the air bubbles are pressed further into the cavities where they collapse. This cause air flow transport of particles and water into the cracks. Thus, the concrete is injected far into the non-consolidated zones.

The aqueous concrete mixture consists of finely ground particles and incorporates dispersing agents as air bubbles forming and stabilising agents. The concrete has a pore volume of at least 20% by volume.

The cited US 5529123 A discloses a method of reducing fluid loss in a formation, wherein a foamed cement composition is used. The method differs from the claimed method in that it does not include any pressure variation steps and the hardened cement comprises an porosity of at least 15%.

.../...

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

The cited SE 506359 C2 discloses a foam concrete with a pore volume of 20%-85%. This concrete differs from the claimed concrete according to claim 7 in that the claim states a certain cement particle distribution and a certain amount of another particular material that has a particle size less than the size of the cement particles.

Thus, the claimed invention is novel. It is also considered that the claimed invention is non-obvious to a person skilled in the art and that it constitutes a solution to the stated problem.

Consequently, the claimed invention is considered to meet the criteria of novelty, inventive step and industrial applicability.

WO 99/36665
PCT/SE99/00047

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NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year) 22 July 1999 (22.07.99)	
Applicant's or agent's file reference P33752PC00 10337S200 SW	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/SE99/00047	15 January 1999 (15.01.99)	16 January 1998 (16.01.98)

Applicant
SENAD TEKNIKBETONG AB et al

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(54) Title: METHOD FOR INJECTING OF FOAMED CONCRETE AND A FOAMED CONCRETE

(57) Abstract

The present invention relates to a method of stabilizing gravel, sand, crushed stone, rock and concrete structures which are cracked, porous or have other cavities difficult of access, and sealing the same against flows of water by injecting a pumpable, low-viscous aerated concrete which is based on an aqueous dispersion containing finely-grand cement, a dispersing agent and optionally a fine-particulate material with a large specific surface. The invention also discloses aerated conctrete which has a pore volume of at least 20 % and contains finely-ground cement with such a particle distribution that at least 95 % pass a screen with a mesh size of 64 μm, and 2-20 %, based on the weight of the cement, of a fine-particulate material with a particle size which is smaller that that of the cement.

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Method for injecting of foamed concrete and a foamed concrete

This invention relates to a method of stabilising gravel, sand, crushed stone, rock and concrete structures which are cracked, porous or have other cavities difficult of access, and sealing the same against flows of water by injecting a pumpable, low-viscous aerated concrete which is based on an aqueous dispersion containing finely-ground cement, a dispersing agent and optionally fine-particulate material having a large specific surface.

When stabilising and sealing gravel, sand, rock and concrete structures, which are porous or cracked, or have other cavities difficult of access, it is generally known to inject pumpable, easy-flow concrete containing cement and frequently various additives, such as accelerators and retarders controlling the curing of the cement, and fine-particulate material promoting the sealing of the cavities. However, it has been found that in many cases it is difficult to achieve a satisfactory result. For instance, it has proved to be difficult to make the injected concrete reach sufficiently far into the narrow cavities to obtain a satisfactory seal against penetrating water. It has also been found to be difficult, in e.g. rock which conducts great amounts of water, to apply the concrete and make it cure before an increase of the water-cement ratio occurs and the concrete is wholly or partly flushed away.

According to the present invention, it has now been found possible to solve these problems and present an effective method of stabilising and sealing gravel, sand, crushed stone, rock and concrete structures. The method is characterised by injecting aerated concrete with a pore volume of at least 20% by volume into the cavities that are difficult of access and are to be sealed. The injection should be carried out by first injecting the aerated concrete at such a low pressure that the aerated concrete remains intact, and then applying an increased pressure,

such that the air bubbles located in or in the vicinity of the cavity are pressed further into the cavities and collapse, whereby air entrains cement and a fine-particulate material, if any, into the cavities, where sedimentation and hydration take place. The pressure when injecting the aerated concrete is suitably below 3 bar while the increased pressure usually is above 6 bar.

By applying the inventive method, it has been found possible to considerably reinforce the stabilisation by the fact that the hydratable concrete mixture can penetrate further into the cracks than is possible when injecting a conventional concrete mixture. The cement is suitably finely ground to such a particle size that at least 95% pass a screen having a mesh size of 64 μm, preferably 34 μm and most preferred 16 μm if penetration into fine cavities is desired. The air bubbles and the escape thereof through the cavities also prevent penetration of water during injection and thus prevent, at least partly, the fresh concrete from being diluted with water and make any flushing away difficult. If the flowing through of water is extremely great or if a low water permeability is desired, it has according to the invention been found to be suitable to use hydrophobic aerated concrete. Preferably the aerated concrete is hydrophobised to such an extent that it does not spontaneously mix with water. As a result, dilution of the mixture with water is avoided while at the same time the risk of flushing away is considerably reduced.

The invention will now be described in more detail with reference to the drawing, in which Fig. 1 illustrates the penetration of the fresh concrete into a crack, and Fig. 2 is an enlarged picture of the encircled portion in Fig. 1.

The present invention also refers to low-viscous, pumpable aerated concrete, which is based on cement with such a particle size that 95% by weight pass a screen having a mesh size of 64 μm and a pore volume of at least 20% by volume. The aerated concrete suitably contains the following

components:

100	parts by weight of cement, ground to such a particle size that 95% by weight pass a screen of the mesh size 64 μm, preferably 32 μm,
0.1-1	parts by weight of a dispersing agent, such as a protein, an anionic surfactant and/or a polymer, and
35-80	preferably 50-70 parts by weight of water,
0-10	parts by weight of a fine-particulate material with a particle size smaller than that of the cement,
0-2.5	parts by weight of a resin having a molecular weight below 10,000 and a saponification rate of 100-250, and
0-2.5	parts by weight of an accelerator, retarder and/ or thickening agent which control the hydration of the cement or gradually increase the viscosity of the concrete, and
0-2	parts by weight of a swelling additive.

The pore volume of the aerated concrete is suitably between 40% and 85% and preferably between 50% and 80%. In connection with very narrow cavities, such as microcracks in rock, the concrete suitably contains 1-10 parts by weight of a fine-particulate material per 100 parts by weight of cement. If hydrophobic aerated concrete is desired, the hydrophobicity can be increased by adding resin in an amount of 0.1-2.5 parts by weight per 100 parts by weight of cement and, optionally, fine-particulate bentonite in an amount of 0.1-3 parts by weight per 100 parts by weight of cement. The concrete usually has a density of 300-1800 kg/m^2, preferably 400-1500 kg/m^2.

Cement is a hydraulic binding agent which, with water, forms a paste and cures by hydration. The curing depends in the first place on the formation of calcium silicate hydrate. The most important silicate-cement-containing composition is Portland cement clinker. When applying the invention use is preferably made of Portland

cement owing to its excellent all-round properties. It contains, among other things, tricalcium silicate, dicalcium silicate, tricalcium aluminate and calcium aluminium ferrite. Other examples of suitable types of cement are Portland slag cement, Portland fly ash cement, Portland pozzolana cement, coloured Portland cement, white Portland cement, low heat Portland cement and rapid hardening Portland cement, which are all based on Portland cement clinker. When using cement in injected concrete, it is convenient to grind cement additionally to such a particle size that at least 95% by weight pass a screen having a mesh size of 32 μm, preferably 16 μm for the concrete to penetrate more easily into narrow cavities. If required owing to the circumstances, a still finer cement can be used.

The dispersing agents are added as air-pore-forming and stabilising additives. Examples of such additives are proteins, nonionic alkylene oxide adducts, xylene sulphonate, alkyl sulphate, alkyl ether sulphate, olefin sulphate and polymer sulphonic-acid-group-containing compounds, such as lignosulphonate, naphthalenesulphonate formaldehyde condensate and melamine sulphonate formaldehyde condensate and mixtures thereof. The proteins, the nonionic alkylene oxide adducts and the short-chain anionic compounds affect in the first place the formation of air pores while the polymer anionic polyelectrolytes primarily contribute to improve stability and pumpability.

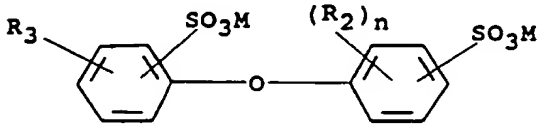
Specially preferred dispersing agents are anionic surface-active disulphonates of the type described in patent application WO 97/39992, where the disulphonates are of the general formula

$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

wherein R is an aliphatic group having 4-20 carbon atoms, m is a number 1 or 2, the sum of the number of carbon atoms in the group or in the groups R being 6-30, R_1 is an aromatic group containing at least 2 aromatic rings and 10-20 carbon atoms, and M is a preferably monovalent cation or hydrogen.

The group R_1 usually contains only carbon and hydrogen, but also oxygen atoms may be included, for instance in the form of ketone groups. Besides having an air-entraining capacity, these compounds yield a hydrophobic aerated concrete which has low viscosity and is easily pumpable.

The disulphonates of formula I suitably consist of compounds where R is an aliphatic group having 6-14 carbon atoms and R_1 is an aromatic group having 10-17 carbon atoms and two aromatic rings. Examples of such disulphonates are those having the following formulae



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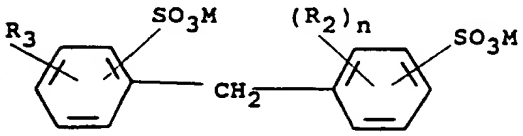

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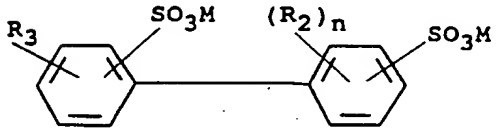

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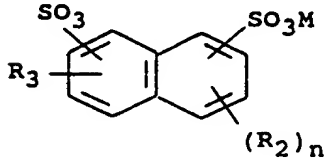

(V)

wherein R_3 is an aliphatic group having 4-20 carbon atoms, M has the above meaning, R_2 is an aliphatic group having 1-14 carbon atoms and n is 0 or 1, preferably 0. The groups R_3 and R_2 are, for instance, a butyl group, a hexyl group, an octyl group, a decyl group or a dodecyl group, which can be straight or branched. The group R_2 can also suitably be a lower alkyl group, such as a methyl or ethyl group. The sum of the number of carbon atoms in the groups R_3 and R_2 is preferably 8-24. These disulphonates result in a stable,

low-viscous aerated concrete which can easily be pumped. Particularly preferred are alkyl-substituted diphenyl ethers.

The fine-particulate material is e.g. fly ash, bentonite (myanite), rock dust, finely-ground lime, gypsum and silica having a particle size which is smaller than that of the cement. It should suitably have a particle size which to at least 95% is below 5 μm and a specific surface in the order of at least 1,500 m^2/kg or higher. Silica having a particle size of 0.1 μm and a specific surface of $2 \cdot 10^4$ is an example of a fine-particulate material having a good penetration capacity. Fly ash, lime and silica also affect the setting of the concrete.

The resins, which can be synthetic or natural, or derivatives thereof are primarily added to increase the strength, water-repelling properties (hydrophobicity) and homogeneity of the concrete. The resins and their derivatives may contain one or more aromatic and/or aliphatic groups having at least 12, preferably 16-35 carbon atoms. The groups can be saturated as well as unsaturated. Preferred resins are those having an acid number from 4 to 170 and a saponification rate from 150 to 175. Examples of suitable resins are different colopholic acids and mixtures thereof, such as colophonium, and their dimerised derivatives as well as wholly or partly saponified, esterified and/or hydrated derivatives thereof. Examples of suitable hydroxyl compounds for esterification are methanol, glycol, glycerol and pentaerythritol. Other examples are modified colophonium resins modified with unsaturated fatty acids, such as maleic acid and their preferably partially esterified derivatives as well as phenol-modified colophonium. Examples of suitable phenols are 4-tert-butyl phenol, nonyl phenol and 4,4'-diphenylolpropane (bisphenol A).

Other examples of additives are retarders or accelerators, which control the hydration of the cement,

thereby adjusting it to the conditions prevailing in injection and making it occur at the desired point of time. Examples of accelerators are alkali salts, such as calcium chloride, sodium hydroxide, potassium carbamide and sodium aluminate, while examples of retarders are saccharides, phosphates, citric acid and lignosulphonate. The latter also has a pronounced dispersing effect. Also the addition of a thickening agent, which gradually develops its viscosity, may serve to prevent the aerated concrete from being flushed away by penetrating water before it has cured. Examples of such thickening agents are saccharide compounds, such as nonionic cellulose ethers, polyurethanes and polyacrylates. Examples of suitable cellulose ethers are hydroxyethyl-cellulose, methylcellulose, methylhydroxyethylcellulose and ethylhydroxyethylcellulose.

Swelling additives are admixed to counteract volume reduction and thus prevent cracks and cavities from being incompletely filled. An example of swelling additives is aluminium powder.

When injecting aerated concrete it is most important for it to be stable. Should the mixture not be stable, the individual cement particles will settle owing to their dead weight and thus block and prevent further injection into, for instance, a system of cracks in a rock. The fine-particulate material having a large specific surface, such as silica, gypsum and myanite, increases the stability of the aerated concrete and can thus be carried by the aerated concrete up to the cracks in the rock. Using aerated concrete having a high content of moisture gives a low-viscous concrete with low shear strength. This fact and also the fact that the air bubbles carry the particles on their surfaces contribute to low viscosity of the fresh concrete and imply that the concrete can be injected at a low pump pressure but still obtain good penetration. The low pump pressure that is necessary for injecting the aerated concrete also gives the advantage of lower demands on the

anchoring of adapters in bore holes. Moreover, the safety for staff handling the equipment can be increased, and the risks of tubes breaking and adapters releasing their hold can practically be eliminated.

Fig. 1 shows the penetrating of the concrete 1 having a high moisture content into a crack 2 in a rock or the like. The arrow 3 indicates the direction of flow of the concrete, the air bubbles in the concrete being designated 4.

As mentioned above, the concrete 1 is pumped preferably through a tube and/or bore hole up to the crack 2 of the rock, the pump pressure being kept at a low level. As also mentioned above, the air bubbles 4 carry cement and other particles of material in an effective way up to and into the crack. Then the pressure in the tube is increased considerably, which means that the air bubbles in the crack collapse and an air flow transport of particles and water into the interior of the crack arises. This means that the cement particles agglomerate well into the crack and cure to a high density concrete, thereby sealing the crack.

According to the invention, the aqueous concrete mixture can be made by mixing water, including a dispersing agent and other organic additives which are soluble or dispersible in water, with dry mortar containing, among other things, cement and optionally a fine-particulate material, to a homogeneous slurry.

Another technique is to combine, during stirring, a main mixture containing the greater part of cement, the greater part of water and fine-particulate material, and a supplementary mixture containing the remaining water, the remaining cement, the dispersing agent and optionally resin and other organic additives. The weight ratio of main mixture to supplementary mixture is usually in the range 20:1 to 2:1.

A further technique of manufacturing the aerated concrete is to supply to a discontinuous or continuous mixer

water, the dispersing agent and optionally resin and other organic additives as well as a small amount of cement, usually 2-40, preferably 5-30% by weight of the total amount of cement (suitably in the stated order). The resulting composition is stirred while increasing in volume to a homogeneous, stable air-containing concrete mixture, whereupon the remaining cement and the fine-particulate material are added in one or more steps or continuously and are mixed while being stirred.

The present invention is further illustrated by the following Examples.

Example 1

A house with a concrete base built on a foundation of sand and stone and subjected to proceeding settlement, was stabilised with aerated concrete according to the invention. The aerated concrete, which had a density of 495 kg/m^3 and an air pore volume of 69%, was based on Portland cement with such a particle size as to allow above 95% by weight to pass a screen with a mesh size of 32 μm and also contained per 100 parts by weight of cement 0.7 parts by weight of decyl-substituted diphenylether disulphonate of formula II and 0.35 parts by weight of Aquatac 6085, a glycerol resin acid ester with an active content of 59% by weight supplied by Bergvik Kemi AB.

The injection tubes were buried at a depth of 100 cm, and the aerated concrete was injected at a pressure of 1 bar, and when it was no longer possible to inject aerated concrete at this pressure, the pressure was increased to 10 bar, whereupon curing took place.

After injection, the settlement ceased and the injected aerated concrete was inspected by digging up the material round the injection tubes. The aerated concrete between stone and gravel had the expected air pore volume, whereas the aerated concrete that had been pressed into narrow spaces and cracks had no air pore volume or a very low such volume.

Claims

1. A method of stabilising gravel, sand, crushed stone, rock and concrete structures which are cracked, porous or have other cavities difficult of access, and sealing the same against flows of water by injecting a pumpable, low-viscous concrete which is based on an aqueous dispersion containing cement, characterised by injecting aerated concrete with a pore volume of at least 20% by volume into the cavities that are difficult of access and are to be sealed, the aerated concrete being first injected at such a low pressure that the aerated concrete remains intact, and the aerated concrete being then exerted to an increased pressure, such that the aerated concrete located in or in the vicinity of the cavities are pressed further into the cavities.

2. A method according to claim 1, the aqueous dispersion comprising finely-ground cement, a dispersing agent and optionally fine-particulate material having a large specific surface, characterised in that in the aerated concrete existing air bubbles collapse when the aerated concrete is pressed further into the cavities, escaping air entraining cement and the fine-particulate material, if any, into the cavities, where sedimentation and hydration take place.

3. A method according to claim 1 or 2, characterised in that the aerated concrete has an air pore volume of 40-85%, is hydrophobic and is not spontaneously miscible with water.

4. A method according to any one of the preceding claims, characterised in that the aerated concrete contains an anionic surfactant of the general formula

$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

wherein R is an aliphatic group having 4-20 carbon atoms, m is a number 1 or 2, the sum of the number of carbon atoms in the group or in the groups R being 6-30, R_1 is an aromatic group containing at least 2 aromatic rings and 10-20 carbon atoms, and M is a preferably monovalent cation or hydrogen.

5. A method according to any one of the preceding claims, characterised in that the aerated concrete contains an accelerator, retarder and/or thickening agent.

6. A method according to any one of the preceding claims, characterised in that the injection of the concrete occurs at a pressure below 3 bar, and that the pressure is then increased to at least 6 bar.

7. Aerated concrete, characterised in that is has a pore volume of at least 20% and contains finely-ground cement with such a particle distribution that at least 95% pass

a screen with a mesh size of 64 μm, and 2-10%, based on the weight of the cement, of a fine-particulate material with a particle size smaller than that of the cement.

8. Aerated concrete according to claim 7, characterised in that it has an air pore volume of at least 40-85% and contains

0.1-1 parts by weight of a dispersing agent,

35-80 preferably 50-70 parts by weight of water,

0-10 parts by weight of a fine-particulate material with a particle size smaller than that of the cement,

0-2.5 parts by weight of a resin having a molecular weight below 10,000 and a saponification rate of 100-250,

0-2.5 parts by weight of an accelerator, retarder and/or thickening agent which control the hydration of the cement or gradually increase the viscosity of the concrete, and

0-2 parts by weight of a swelling additive per 100 parts by weight of cement.

9. Aerated concrete according to claim 8, characterised in that the dispersing agent contains a disulphonate of the general formula

$$(R)_m\text{-}R_1\text{-}(SO_3M)_2 \qquad (I)$$

wherein R is an aliphatic group having 4-20 carbon atoms, m is a number 1 or 2, the sum of the number of carbon atoms in the group or in the groups R being 6-30, R_1 is an aromatic group containing at least 2 aromatic rings and 10-20 carbon atoms, and M is a preferably monovalent cation or hydrogen.

10. Aerated concrete according to any one of the claims 7-9, characterized in that it contains 0.1-2.5 parts by weight of the resin in claim 8.

11. Aerated concrete according to any one of the claims 7-10, characterized in that it contains 2-10% by weight of the fine-particulate material in claim 8, and that the cement has such a particle size that 95% by weight pass a screen with a mesh size of 32 μm.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00047

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: E21B 33/138, C04B 38/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E21B, C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5529123 A (CARPENTER ET AL), 25 June 1996 (25.06.96)	1-11
A	GB 2164328 A (BLUE CIRCLE INDUSTRIES PLC), 19 March 1986 (19.03.86)	1-11
A	SE 506359 C2 (AKZO NOBEL SURFACE CHEJISTRY AB), 8 December 1997 (08.12.97)	1-11
A	GB 2192392 A (REDLAND ROOF TILES LIMITED), 13 January 1988 (13.01.88)	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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